Water Standards and Studies Report 89-1

Bibliography of Water Standards and Studies Section Publications 1988

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MANITOBA DEPARTMENT OF ENVIRONMENT

WATER STANDARDS AND STUDIES REPORT #89-1

SUMMARY

Brown, D.J. 1989. Bibliography of Water Standards and Studies Section Publications, 1988. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies Report #89-1. 18pp.

The Water Standards and Studies Section, Environmental Management Services Branch, Manitoba Environment produced twelve manuscript reports, three refereed journal papers, two papers published in Conference Proceedings and gave an additional four presentations.

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INTRODUCTION

The reports listed in this document were prepared by staff of the Water Standards and Studies Section, Environmental Management Services Branch of the Manitoba Department of Environment. Each report was distributed by the Department as it became available. Enquiries for copies of the reports should be directed to the following:

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MANUSCRIPT REPORTS

REPORT 88-1 Brown, D.J. 1988. Bibliography of Water Standards and Studies Section Publications, 1987. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies. 14pp.

SUMMARY

The Water Standards and Studies Section, Environmental Management Services Branch, Manitoba Environment produced seven manuscript reports, one refereed journal paper, two papers published in Proceedings and made an additional four presentations.

REPORT 88-2 Williamson, D.A. 1988. Classification of Clearwater Lake, Manitoba: High Quality Designation, Manitoba Surface Water Quality Objectives. Environmental Services Branch. Manitoba Environment. Water Standards and Studies. 27pp.

SUMMARY

Clearwater Lake is a large lake of exceptional clarity located in west-central Manitoba approximately 25 km northeast of The Pas. This lake is extensively used for various purposes, including recreation. Clearwater Lake also provides genetic stock for whitefish and lake trout stocking programs in Manitoba. The water quality of Clearwater Lake became the focus of attention in 1987 during a public review of a proposal that included discharging treated domestic sewage effluent, generated from camping facilities at Clearwater Lake, into a nearby marsh area. Drainage from this marsh area eventually flows back into Clearwater Lake.

Local residents expressed their concerns regarding this proposal in the form of petitions, editorial letters to the local

newspaper and submissions at a Clean Environment Commission public hearing. The message to water quality management officials was explicit. Local residents wanted an additional degree of environmental protection for Clearwater Lake not normally afforded other water bodies within Manitoba.The original sewage effluent proposal was subsequently revised to consider only those options that would result in the discharge of treated effluent outside the Clearwater Lake watershed in order to give high priority to the concerns of local residents.

The Manitoba Surface Water Quality Objectives provide a mechanism to implement several levels of protection for aquatic environments. The "High Quality" designation was intended to apply to site-specific cases such as Clearwater Lake. Application of such a designation would ensure long term protection of the intrinsic water quality characteristics of Clearwater Lake while recognizing that development within the area is still desirable. Such a designation, therefore, may be associated with additional costs. These costs are difficult to estimate, but could be realized in terms of increased user fees for activities within the Clearwater Lake area. Other costs could result within resource recovery sectors located within the Clearwater Lake watershed. Such costs may be reflected within both the regional and Manitoba economies.

REPORT 88-3 Beck, A.E. 1988. Nutrient enrichment study of Shoal Lake (Western Manitoba).Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies. 67pp.

SUMMARY

The council of the R.M. of Shoal Lake requested the Manitoba Department of Environment and Workplace Safety and Health to conduct a water quality study on Shoal Lake. The ultimate intent of the project was to develop a realistic and effective strategy for rehabilitation of lake water quality such that the aesthetic and recreational appeal of the lake would be restored. athe goal of the present study was to provide a baseline for such a strategy by defining the severity of the problem and by identifying the causes of the problem.

The study commenced in March, 1987 as a joint effort between the Councils of the R.M. and of the Village of Shoal Lake and Water Standards and Studies Section of the Manitoba Department of Environment. The Councils' responsibilities included sample collection and provision of necessary background information. The responsibilities of Water Standards and Studies Section included sample analyses, data interpretation and report preparation. Interpretive aids and applied procedures included assessment of trophic status, identification of the problem nutrient and development and validation of a phosphorus budget.

As suggested by the occurrence of extensive blue-green algae blooms, Shoal Lake was found to be a hyper-eutrophic waterbody. This means that the water is very rich in nutrients, that biological productivity is very high and that the water quality generally was not suitable for body contact recreational purposes. Phosphorus was confirmed as the problem nutrient which controlled algae and macrophyte production in Shoal Lake. Internal recycling from lake sediments accounted for approximately 51.9% of the total phosphorus loading to the water column of Shoal Lake. Phosphorus release from sediments during anoxia was estimated at 1402 Kg per year and effective phosphorus release from sediments due to wind induced turbulence was estimated at 626.9 Kg per year. Runoff from the drainage basin

accounted for approximately 77.5% of gross external loading. Excessive phosphorus loadings within the drainage basin were attributed primarily to concentrated livestock holdings located along the Oak River within approximately 1.5 Km upstream of Shoal Lake and secondarily to pastures which straddled the Oak River at sites several kilometres further upstream. Approximately 10.7% of the gross external phosphorus loading to Shoal Lake was attributable to the Village of Shoal Lake sewage lagoon discharges and approximately 10.4% was attributable to precipitation, dust and other materials aerially deposited. Phosphorus loadings attributable to rural residences, cottages and campground were estimated at approximately 1.5% of the gross external loading.

REPORT 88-4 Beck, A. E. 1988. Recreational development capacity study of six lakes in the South Riding Mountain Planning District (1986). Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies. 103 pp.

SUMMARY

The South Riding Mountain Planning District Board requested that recreational development capacity studies be conducted on twelve lakes located within the Planning District. The Board's goal was to develop guidelines for recreational development such that lake water quality was maintained, that the aesthetic appeal of the area was not impaired and that prospective water based recreational activities could be safely accommodated.

The study commenced in July 1985 as a joint effort between the Board and Water Standards and Studies Section of the Manitoba Department of Environment and Workplace Safety and Health. Board responsibilities included sample collection and provision of required background information. The responsibilities of Water Standards and Studies Section included sample analysis, data interpretation and report preparation. Interpretive aids and applied procedures included assessment of trophic status, identification of problem

nutrients, development and validation of phosphorus budgets and calculation of cottage capacities and boat capacities.

The results obtained from seven of the lakes studied were particularly successful from the viewpoint of acheiving study goals (Beck, 1987). Additional work was required on the remaining five lakes. Additional study of these five lakes plus study of a sixth, Wolf Lake, was undertaken during 1986. The 1986 results are discussed in the present report.

Both Otter Lake and Little Jackfish Lake were found to be hyper eutrophic. This means that the water quality generally is not considered suitable for body contact recreational purposes. Nitrogen availability controlled algae and weed growth in Little Jackfish Lake while phosphorus controlled production in Otter Lake. Significant conflicts between various water based recreational activities are unlikely at present rates of utilization of these waterbodies. Valid phosphorus budgets again could not be developed for either lake. However, the advanced state of eutrophy rendered both lakes unsuitable for permanent recreational developments. Therefore, it was recommended that further recreational development of a permanent nature be permitted on neither Otter Lake nor Little Jackfish Lake.

Sandy Lake was confirmed to be an eutrophic lake. The water quality generally is considered suitable for recreational purposes except during major algae blooms. Phosphorus availability controlled algae and weed production in the lake. Significant conflicts between various water based recreational activities are unlikely even at the present moderate to heavy rate of utilization by boats. Similar to Otter and Little Jackfish lakes, a valid phosphorus budget could not be developed. The state of eutrophy and the advanced level of recreational development about the lake suggested that it has already been developed to a point near its maximum potential. Therfore it was recommended that further recreational development not be permitted on Sandy Lake.

Both Dummy Lake and Stewart Lake were found to border on the

eutrophic state. The water quality of each was considered suitable for recreational purposes except during severe algae blooms. Phosphorus availability controlled algae and weed production on these lakes. The phosphorus loading rates to both lakes were very excessive. Due to background phosphorus loadings, the water quality of both lakes was expected to deteriorate over time. Both lakes have the potential to accomodate additional development without detectably affecting water quality. Thus it was recommended that future development at Dummy Lake not exceed a total of 109 additional cottage equivalents. These latter were to be calculated at the rate of 1 cottage = 0.147 residences = 2.22 campsites/day use sites. Future development at Stewart Lake was recommended not to exceed a lake total of 131 additional cottage equivalent units. These were to be calculated at the rate of 1 cottage = 0.147 residences = 1.54 campsites/day use sites. Due to very excessive background phosphorus loading rates, it was further recommended that potential developers and prospective recreational investors be advised that occasional water quality problems can be anticipated.

Wolf Lake was found to be a moderately eutrophic waterbody and the lake water quality generally was suitable for recreational purposes except during severe algae blooms. Phosphorus availability controlled algae and weed growth in the lake. The rate of background phosphorus loading was very excessive and would cause rapid deterioration in water quality conditions unless ameliorative actions were taken. Due to the excessive rate of phosphorus loadings and the rate of water quality deterioration, it was recommended that permanent recreational developments not be permitted on the lake. Temporary developments, however, could be accomodated to a lake maximum of 105 campsites/day use sites.

REPORT 88-5 Williamson, D. A. 1988. Rationale document supporting revisions to Manitoba Surface Water Quality Objectives. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies. 95pp.

SUMMARY

Surface water quality objectives were developed for application within Manitoba in 1976 in order to assist water quality management activities. These objectives underwent several minor revisions in 1979, then a number of major revisions were proposed in 1983. The revisions proposed in 1983 were circulated widely within Manitoba and Canada in order to solicit constructive criticism. The Clean Environment Commission convened a public hearing in November, 1984 to review the proposed revisions in a public forum and to ensure that all those likely to be affected by the changes had an opportunity to comment. The Clean Environment Commission submitted a report in September, 1985 to the Minister, Manitoba Department of Environment and Workplace Safety and Health discussing the findings of their review. This report contained a number of recommendations, only one of which pertained directly to elements of possible technical deficiency within the proposed revisions. The Clean Environment Commission recommended that these issues be re-examined. The following report discusses these areas of contention.

Additionally, new scientific information has become available such that revisions to the specific objectives for the parameters un-ionized ammonia, arsenic, cadmium, chlorine, chromium, copper, cyanide, lead, and mercury are warranted. Rationale is provided to support changes to the objectives for these materials. Minor changes are also warranted to the bacteriological indicator organism objectives for recreational waters. A discussion is included regarding the applicability to Manitoba of recent changes to the recreational water quality criteria in the United States.

Overall, the objectives for these parameters are less restrictive than previously recommended, while providing the same degree of protection as previously envisaged.

This document was circulated for review to numerous agencies and individuals including members of the Interdepartmental

Advisory Committee on Water Quality Objectives, municipal and industrial corporations, staff within the Canada Departments of Environment and Fisheries and Oceans as well as the Manitoba Environmental Council and the Clean Environment Commission.

Future revisions will continue to be proposed to the Manitoba Surface Water Quality Objectives as more experience is gained and as new scientific information becomes available.

REPORT 88-6 Williamson, D. A. 1988. Hexazinone residues in surface and groundwater at two sites within Agassiz Provincial Forest, Manitoba, Canada. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies. 39pp.

SUMMARY

Studies were undertaken at two sites within the Agassiz Provincial Forest, Manitoba, Canada, to determine the fate and effect of Velpar L on aquatic systems. Velpar L contains the active ingredient hexazinone in a 240 g/L water dispersible solution and was used to contro' deciduous vegetation in reforestation plantations. Surface water and groundwater were monitored for hexazinone residues. Conventional flask and microplate algal bioassays were conducted using the unicellular alga Selenastrum capricornutum Printz and a Microtox bioassay was undertaken using Photobacterium phosphoreum . Such bioassays were conducted to assist in inferring the nature and extent of potential impacts of hexazinone on surface water systems.

Both lateral off-site migration and vertical migration of hexazinone were observed within the surficial aquifer at the study sites. Lateral movement was limited to the extent that less than 10 ug/L were detected in groundwater samples within 5 m of the application site. Hexazinone residues were detected in test wells for a period of approximately 1000 days

following application. Hexazinone appeared to move downward in a relatively narrow band at a rate that was artificially enhanced due to the effect of groundwater sample extraction. The maximum observed hexazinone concentration in groundwater was less than the 2.0% of the calculated tentative maximum acceptable drinking water criteria derived for the protection of human health. Velpar L was not mutagenic as evidenced by a S.O.S. chromotest using the bacterium Escherichia coli.

Hexazinone residues were detected within ephemeral pools that formed on treated soils for a period of approximately 1000 days following application. It was determined that the principal impact upon surface water aquatic systems following hexazinone contamination, would result from inhibition of primary productivity. Such impacts would be realized at relatively low hexazinone concentrations (22.5 ug/L) as determined by algal bioassay studies. Secondary effects may be manifested in other ecological compartments, depending upon the magnitude and duration of contamination.

REPORT 88-7 Williamson, D. A. 1988. A four year study of bacteriological characteristics at recreational beaches, Manitoba, Canada. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies.

SUMMARY

The bacteriological characteristics of thirty-five beaches were monitored in Manitoba during 1984, 1985, 1986 and 1987. Fourteen of these beaches were assessed each year; the others were monitored on one or more years during the study period. The principal objective of the study was to determine whether or not the bacteriological quality of the major Manitoba beaches were acceptable in relation to surface water quality objectives for primary recreational activities. Additional information was also acquired that resulted in a greater understanding of microbial populations in Manitoba surface

water. Such information, useful in water management programs, included the generation of data on fecal streptococci, Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa, and determination of bacterial species enumerated in the fecal coliform and fecal streptococci analyses.

The data were compared to the 60% and 90% confidence intervals for the 30-day geometric mean and 1-day geometric mean fecal coliform objective of 200 organisms/100 mL. All beaches monitored did not exceed the 30-day objective during the study period with the exception of Matlock Beach, Lake Winnipeg, and on one occasion during 1984. Other beaches were of acceptable quality in comparison to the recreational water quality objective during this averaging period. Most beaches located on Lake Winnipeg, however, exceeded at least the 60% confidence limit for the 1-day geometric mean fecal coliform objective on one occasion during each of the four years of the investigation. Extensive follow-up of such exceedences indicated that the events occurred at apparently random intervals and could not be readily associated with other possible contributing factors such as bather load, precipitation, wind direction or point-source contributions of fecal coliform bacteria. It was thought that the additional risk to bathers during these brief periods of time was not acceptable.

Similar exceedences of the 1-day geometric mean fecal coliform objective were observed on Lake Dauphin beaches during 1986 but not during 1987. A single exceedence of the 1-day fecal coliform objective was observed at Red Rock Lake, located within the Whiteshell Provincial Park, during the summer of 1987. All other beaches monitored in the central, western, southern and eastern regions of Manitoba did not exceed the fecal coliform objective.

The data generated during this extensive investigation adequately characterized the bacteriological quality of the beaches in the most heavily populated region of Manitoba. It is therefore not necessary to conduct further monitoring of this

nature in the near future unless to address specific concerns or problems as evidenced by new medical information. Additional studies would also be warranted should alterations in major land-use practices occur near recreational areas or additional discharges of wastes of enteric origin be directed towards bathing areas.

REPORT 88-8 Williamson, D.A. 1988. Data supplement: A four year study of bacteriological characteristics at recreational beaches, Manitoba, Canada. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies.

REPORT 88-9 Keleher, J.J. 1988. Manitoba: Aquatic LRTAP data and bibliography. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies.

SUMMARY

Manitoba data relevant to the problem of long-range transport of atmospheric pollutants (LRTAP) is widely disseminated through the literature and unpublished documents. The present report provides a compilation of all available Manitoba data for pH, total alkalinity, specific conductance and calcium to 1983. The data pertain to 460 different lakes and approximately 148 streams and rivers. Comparable data for time periods at least five years apart are available for 28 of the lake locations. A minimum of 95% of the references provided pH data but only about 20% provided data on other parameters.

The second part of the present report consists of a bibliography. A total of 255 references spanning the period 1933 to 1983 are cited.

REPORT 88-10 Hughes, C.E. 1988. A comparison of ammonia in acidified and non-acidified water samplas collected from the Assiniboine, Souris, Red and Whitemud rivers, April 8, 1986 to February 3, 1987. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies.

SUMMARY

One hundred and five pairs of acidified and non-acidified water samples, collected from 15 stations located on the Assiniboine, Souris, Red and Whitemud rivers between April 8, 1986 and February 3, 1987 were presented for total ammonia analysis at the W.M. Ward Technical Services Laboratory, Winnipeg, Manitoba. Acidified water samples were preserved with the equivalent of 0.8 mL concentrated sulfuric acid per litre. All samples were stored at or near 4 degrees C prior to analysis. Analyses were conducted as soon as possible after sample collection and normally within 24 hours of collection. Statistical analyses indicated no significant difference between ammonia results from paired acidified and non-acidified water samples at 13 of 15 stations and in the combined data set.

REPORT 88-11 Hughes, C. E. 1988. Interlaboratory comparisons of total ammonia in water: W.M. Ward Technical Services Laboratory and City of Winnipeg Laboratory Services Branch. Environmental Management Services Branch. Manitoba Environment. Water Standards and Studies.

SUMMARY

Forty-one pairs of water samples were collected from the Red River at six locations between and including the south floodway gate at St. Norbert and Lockport from February 27 through May 28, 1987. Personnel from the City of Winnipeg collected all samples. A set of untreated samples was submitted for analyses of total ammonia to the W. M. Ward Technical Services Laboratory. A second set of samples were

preserved with the equivalent of 0.8 mg of mercuric chloride per L and analyzed by the City of Winnipeg. Both sets of samples were stored at 4 C prior to analyses. Analyses of the untreated samples was conducted as soon as possible after sample collection and normally within 24 hours of collection. Both laboratories utilized Technicon Autoanalyzer II automated phenate methods for total ammonia analyses. The City of Winnipeg and W. M. Ward Technical Services Laboratory utilized analytical ranges of 0.20 to 10.0 mg/L and 0.02 to 1.0 mg/L, respectively. Statistical analyses indicated that total ammonia concentrations of 0.3 mg/L or greater were comparable between the two laboratories.

----------Duncan, D.A. and D. A. Williamson. 1988. Water chemistry/ water discharge relationships within the Churchill River Diversion and Lake Winnipeg regulation region, Manitoba, Canada. Report Number 88-5. Ecological Report Series. Northern Flood Agreement Manitoba. Canada/Manitoba.

SUMMARY

Statistically significant linear relationships were evident between a number of water chemistry parameters and discharge at various sites within the Churchill River diversion and Lake Winnipeg regulation region. Linear relationships that were similar and present both before and after development are most useful for providing corroborative evidence that water chemistry changes are coincident with development. These relationships are also beneficial in assisting the focus of future field activities on events that may have the greatest impact upon water chemistry and in predicting potential water quality changes associated with future discharge alterations. Such relationships were observed for the parameters conductivity, alkalinity, calcium and chloride in the Burntwood River at Thompson, total phosphorus in the Churchill River upstream of Granville Lake and conductivity and calcium in Little Playgreen Lake near Norway House.

Numerous relationships between water chemistry parameters and discharge have been significantly altered likely as a consequence of development. These relationships provide direct evidence that changes occurred within the system, but can only be used to indirectly corroborate previously identified water chemistry changes associated with development. Relationships that were statistically significant after development might be used cautiously to predict potential changes in water chemistry coincident with future alterations in discharge. Such relationships occurred for a number of parameters at most sites, including non-filterable residue, pH, total organic carbon, and total Kjeldhal nitrogen in the Burntwood River at Thompson, non-filterable residue, pH, alkalinity, magnesium, hardness, potassium, sodium and chloride in the Nelson River ar Cross Lake, plus others.

Other parameters were not linearly related with discharge during either the pre-development or post-development period. Such parameters included sulphate and magnesium in the Burntwood River at Thompson, non-filterable residue, potassium, sodium, colour, chloride and sulphate in the Nelson River at Split Lake, plus others. This assessment indicates that relationships between water chemistry and discharge are complex and vary with location and time.

JOURNAL PAPERS

Betcher, R.N., M. Gascoyne and D.J. Brown. 1988. Uranium in groundwater of southeastern Manitoba, Canada. Can. J. Earth Sci. 25:2089-2103.

Goldsborough, L.G. and D.J. Brown. 1988. Effect of Glyphosate (Roundup formulation) on periphytic algal photosynthesis. Bull. Environ. Contam. Toxicol. 41:253-260.

Williamson, D.A. 1988 Hexazinone residues in surface and groundwater at two sites within Agassiz Provincial Forest, Manitoba, Canada. Water Poll. Res. J. Can. 23(3):434-449.

PUBLISHED PROCEEDINGS

Brown, D.J. 1988. Agricultural chemical residues in the aquatic environment. 16 pp. IN. Agricultural Chemicals in the Environment. Manitoba Institute of Agrologists, Western Branch.

Playle, R.C., D.A. Williamson and D.A. Duncan. 1988. Water chemistry changes following diversion, impoundment and hydroelectric development in northern Manitoba, Canada. P. 337-352. Proceedings of the Symposium on Interbasin Transfer of Water: Impacts and Research Needs for Canada. Canadian Water Resources Association.

PRESENTED PAPERS

Brown, D.J. Introduction to limnology. Paper presented at the 34th Annual Water and Waste School. Winnipeg, Manitoba. February 16-20, 1988.

Brown, D.J. Agricultural chemical residues in the aquatic environment. Manitoba Institute of Agrologists, Western Manitoba Branch. Brandon, Manitoba. February 24, 1988.

Williamson, D.A. Manitoba surface water quality objectives. Paper presented at the 34th Annual Water and Waste School. Winnipeg, Manitoba. February 16-20, 1988.

Williamson, D.A. Water quality of Dauphin Lake and tributary streams. Presentation to Dauphin-Ochre School Division Science Teachers. April 25, 1988.